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Interface Specification

INNER TRIPLET QUADRUPOLE MQXA

Abstract

MQXA quadrupoles are the principal component of LHC inner triplet LMQXA and LMQXC assemblies. This specification defines the mechanical and electrical interfaces of the MQXA quadrupole, which are relevant for the incorporation of these elements into the LMQXA and LMQXC cold mass assemblies and subsequently into the cryostats which completes the LQXA and LQXC cyro-assemblies.

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1. INTRODUCTION

Each inner triplet of LHC [1] is assembled from a set of components, including the main quadrupole elements MQXA and MQXB, and corrector elements MCBX, MCBXA, and MQSXA (Figure 1). MQXA quadrupoles [2] are the principal component of the LMQXA and LMQXC helium vessels. In addition to providing the main quadrupole field, the MQXA provides mounting points for the MCBX, MCBXA, and MQSXA correctors, end domes, and helium containment pipes.

The MQXA are designed and produced by KEK, and incorporated with other components into helium vessels and cryostatted assemblies (LQXA and LQXC) by Fermilab. This specification defines the mechanical and electrical interfaces of the MQXA quadrupole, which are relevant for the incorporation of these elements into the LMQXA and LMQXB cold mass assemblies and subsequently into the LQXA and LQXB cryo-assemblies.

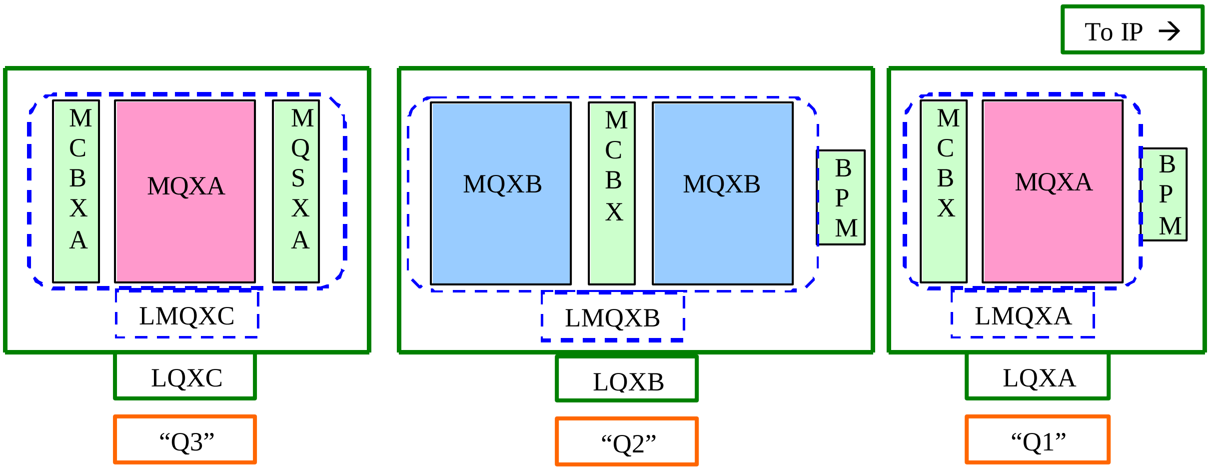

Figure 1. Layout of one side of an interaction point showing assembly packages

1. MQXB INTERFACES

1.1 MECHANICAL

The MQXA quadrupole has a mechanical envelope and mass as defined in [3]. This envelope is consistent with the volume provided in the LMQX assembly, and the end rings of the magnet provide mounting surfaces for end domes, helium containment pipes, and corrector mounting while the end plates provide mounting surface for the thermometers and the warm up heaters. The drawing also shows:

- The diameter and length of the magnet,
- The longitudinal position of the magnetic center relative to the end plates,
- Stay-clear areas for the attachment of cryostat supports, and for attachment of corrector mounting rings,
- End ring features required for welding end domes and attaching the corrector mounting rings, and,
- The envelope of the lead splice block.

The bore of the MQXA coil has a 70mm inside diameter, allowing for the insertion of a 67 mm O.D. insulated beam tube after assembly.

1.2 ELECTRICAL

The MQXA has two 8kA leads extending from the lead end of the assembly. The leads will be labeled A and B according with the CERN standard [4]. Looking toward the lead end, the "A" lead lies below the "B" lead, as shown in Figure 2. The leads exiting the splice block are 0.8m (0.5m minimum) long, such that further routing and splicing can be completed.

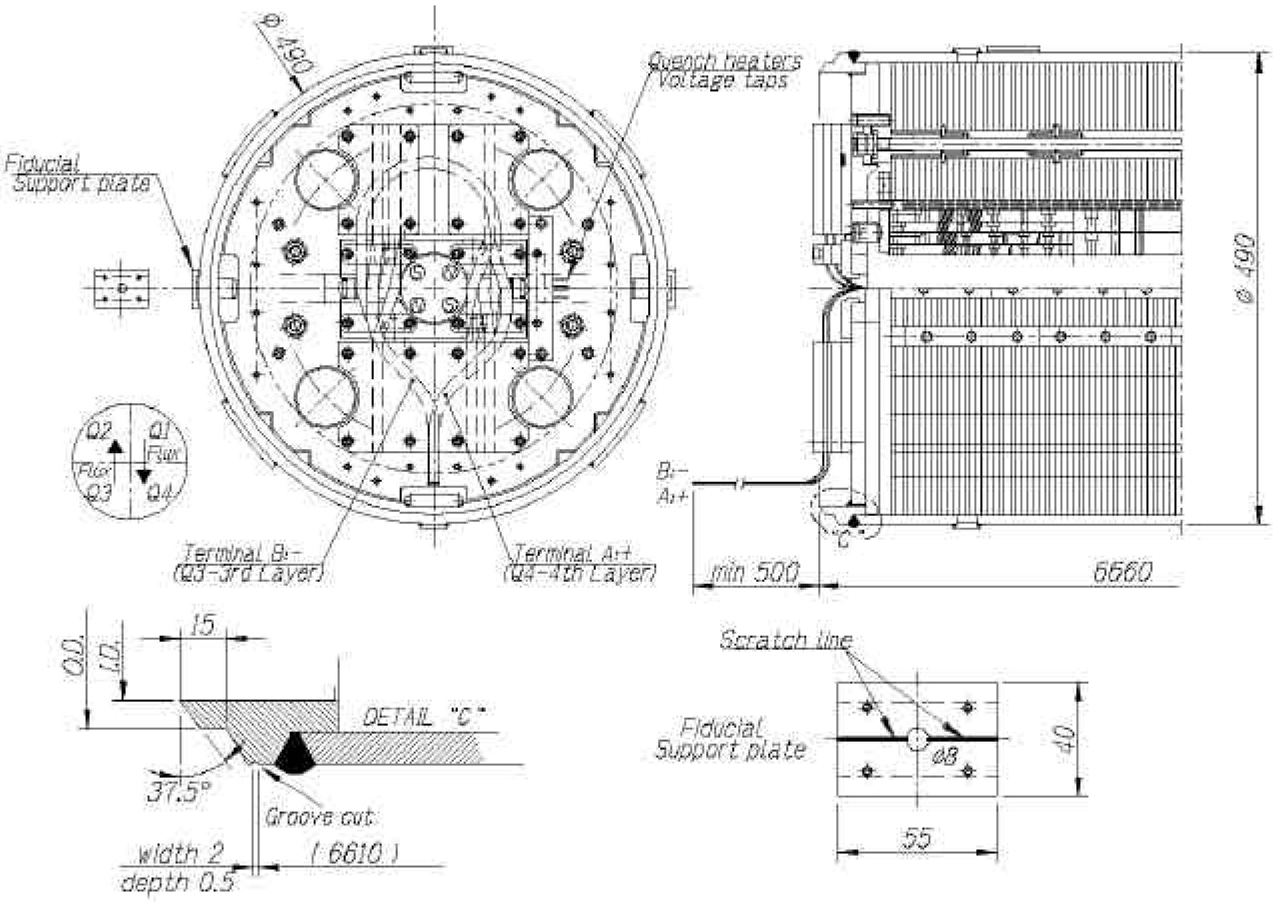

Figure 2. Electrical and survey layout for MQXA assembly.

The instrumentation and control wiring required for the MQXA is listed in Table 1. All voltage tap and quench heater wires exit from the lead end of the magnet. Temperature sensor and warm-up heater wires, which originate at the non-lead end of the magnet, will be routed through the MQXA cold mass when the magnets are assembled together into an LMQXA or LMQXC cold mass. Each wire will be labeled indicating functionality and, for voltage taps, location.

Each magnet has 6 voltage taps, attached to the leads and midpoint of the coils. There are two taps for redundancy at each location. The voltage tap wire is 26 gauge in accordance with [5], and each wire is 2 m long when the MQXA is delivered for assembly.

The MQXA has 2 parallel quench protection heater circuits, resulting in 4 wires 20 gauge, each 2 m long, exiting the lead end of the magnet.

Two temperature sensors are attached to the non-lead end of the magnet for cryogenic measurement and control. The thermometers are attached to the MQXA end plates by Fermilab during assembly of the LMQXA or LMQXC cold mass assemblies. The temperature sensor wires are 30 gauge, each 9m long.

A 50 W warm-up heater is attached to each end of the magnet. These units are attached to the MQXA end plates by Fermilab during assembly of the LMQXA or LMQXC cold mass assemblies. The leads of the heaters are 26 gauge, each 9m long.

Naming conventions for the control wires are shown in Table2.

Table 1. Instrumentation and control wiring. The external lengths are measured from the lead end plate for the voltage tap and quench heater wires and from the non-lead end plate for the temperature sensor and warm-up heater wires.

Lead	Length	Description
Voltage taps	2 m	2 cables (3-#26 AWG wires each)
Quench heaters	2 m	2 pairs (total 4 wires, #20 AWG.)
Temperature sensors	9 m	2 twisted quads (total 8 wires, #30 AWG.)
Warm-up heater	9 m	2 twisted pairs (total 4 wires, #26 AWG.)

Table 2. Naming Conventions for control wiring.

Lead	Tag Name	Description
Voltage taps	A1, A2	Taps from A leads.
	B1, B2	Taps from B leads
	C1, C2	Center taps
Quench heaters	HA1, HB1	Heater Circuit 1
	HA2, HB2	Heater Circuit 2
Temperature sensors	TBD	To be intalled at FNAL
Warm-up heater	TBD	To be installed at FNAL

1.3 ALIGNMENT

Alignment information for the MQXA is transmitted via marks on two fiducials located nearest the lead end of the magnet, in the horizontal plane. The roll of the magnet will be determined by KEK by measurement of fiducials along the length, while the magnet is supported at the same positions as when the magnet will be installed in the cryostat (+/-2100mm from the mechanical center). Scribe lines will be made on the reference support plate of the two lead end fiducials indicating the average field angle over the whole magnet to within 0.2mm. The scribe lines will be visible from the lead end. The magnetic axis is assumed to be co-linear with the center of the outside surface of the cold mass skin.

The longitudinal mechanical center of the magnet will be marked via a scribe line at the horizontal plane, on both side of the magnet. The center shall be measured from the inboard edge of grooves cut in the outer edge of the weld rings located at the lead and return ends of the magnet. (See Figure 2). The magnetic center is located 15mm towards the return end from this mark with an accuracy of +/-2 mm. (The length between the scribe lines at the end rings are 6610 +0/-10 mm, i.e. the position of the end ring scribe line is 3305 +0/-5 mm. However, the shell and end rings are aligned such that the final central scribe line will be at the 15 +/-2 mm from the magnetic center.)

1.4 END RING

The end ring structure is shown in Figure 2. The inner and outer diameter of the end ring (noted as I.D. and O.D. in the Figure 2) should be 448.25 < ID < 450.25 mm and 466.25 < OD < 468.25 mm. The end ring should be checked with the sample support structure to confirm their compatibility prior to the magnet shipping to FNAL. The magnet end will be cut at the length of 3330 +/-2 mm from the central scribe line.

2. REFERENCES

[1] INNER TRIPLET SYSTEMS AT IR1, 2, 5, AND 8, CERN Functional Specification LHC-LQX-ES-0001.

[2] INNER TRIPLET QUADRUPOLE MQXA, CERN Functional Specification LHC-MQXA-ES-0001 rev 1.0

[3] LHC IRQ CRYOSTAT MQXA INTERFACE SPECIFICATION, drawing LHCMQXA_0001 (Fermilab drawing 5520-ME-390108).

[4] LHC MAGNET POLARITIES, CERN Specification LHC-DC-ES-0001.00, rev 1.1, 27 April 1999.

[5] INSTRUMENTATION WIRES, CONNECTION TECHNIQUES AND FEEDTHROUGHS FOR THE LHC CRYOMAGNETS AND THE QRL, CERN Specification LHC-QI-ES-0001, rev 2.0, 27 September 2000.